2011

NASA Range Safety Annual Report

III. AGENCY PROGRAM

A. Development, Implementation, Support of Range Safety Policy

1. Launch Support Policy

In 2011, NASA Range Safety assisted the KSC RS Rep in working with the 45th Space Wing to coordinate the review and update to KCA-1308, "Memorandum of Agreement (MOA) Establishing the Joint Operating Procedure (JOP) Between The United States Air Force (USAF) 45th Space Wing (45 SW) and the National Aeronautics and Space Administration's John F Kennedy Space Center (NASA-KSC) for Safety". This MOA establishes relationships between the 45 SW and NASA-KSC for safety support for things such as hazardous operations, mishap/accident investigations, and transporting hazardous commodities.

2. Range Commanders Council Range Safety Group (RSG) Recap

The Range Commanders Council (RCC) was founded in 1951 to provide a way for DoD test ranges to communicate and discuss common problems.

The RCC Range Safety Group (RSG) continues to provide a forum in which ranges can standardize, develop, and improve on a variety of subjects and processes related to range safety. NASA participates in this forum on a regular basis and became an official voting member in 2008. Range Safety representatives from NASA HQ, KSC, DFRC, and WFF) actively support the RSG and its subcommittees on a regular basis. DFRC is currently the Flight Termination Systems Committee Chair while WFF became the RSG Chair in 2011 and led the entire RSG. Two RSG meetings were held during 2011, as summarized below.

a. 108th Range Safety Group Conference

The 108th Range Safety Group Conference was hosted by the Air Armament Center (AAC) located at Eglin Air Force Base on May 17-19, 2011. The RSG main committee, Risk Committee, and Flight Termination Systems Committee (FTSC) participated in the conference.

In the main committee, Eglin-AAC, the host range, presented an orientation briefing regarding operations occurring at AAC. Other presentations in the main committee were RCC Executive Committee updates and a briefing regarding an advanced Flight Termination System being developed by the L-3 Communications Fuzing and Ordnance Systems directorate.

Several topics were discussed at length by the group in the Risk Committee, including aircraft protection, aircraft hazard area analysis, launch and reentry benchmarks, debris catalog discussion, probability of failure database and guidelines for ELVs, and population and sheltering guidelines.

In the FTSC, DFRC gave a presentation regarding Enhanced Flight Termination System (EFTS) implementation and testing efforts occurring at DFRC/Edwards AFB. Vandenberg Air Force Base (VAFB) personnel gave a briefing developed by the Common Standards Working Group (of which NASA Range Safety is part) regarding potential changes to battery requirements of RCC 319 based on range user inputs.

b. 109th Range Safety Group Conference

The 109th Range Safety Group Conference was hosted by Pacific Missile Range Facility (PMRF) on November 15-17, 2011. The RSG main committee, Risk Committee, and FTSC participated in the conference.

In the main committee, the host range (PMRF) gave an introductory brief on the various operations they conduct. Other presentations in the main committee were range reports along with a "Green Fuel" presentation by WFF and an update on the statuses of group tasks. The 110th Range Safety Group Conference is tentatively scheduled to take place at Point Mugu in the spring of 2012.

Several topics were discussed in the Risk Committee (RC), including debris catalogue models, ship surveillance guidelines, and the use of FAA air traffic data.

Regarding debris catalogues, launch vehicle providers, as launch systems experts, were expected to provide debris catalogues for their respective launch vehicles. These catalogues are used in a variety of risk models used by the Eastern Range (ER) and Western Range (WR). The ER developed a debris catalogue model for solid-fueled vehicles called FRAG45 so that user-provided catalogues could be reviewed in an independent fashion. While not widely used, the RC is evaluating the model and its suitability for widespread use. The ER took this a step further by producing a model for liquid-fueled vehicles as well and presented highlights. The RC will be studying if and how these models might be used in future discussions.

Regarding ship surveillance guidelines, the RC is examining whether there should be RSG guidelines defining when ship surveillance activities are undertaken. At present, each range handles this decision in accordance with local guidelines. The following questions will need to be addressed by the RC if guidelines are to be written:

1. What drives the range surveillance decision?
2. What are the legal ramifications of merely informing shipping traffic via announcements should a casualty occur?
3. How effective have past notices been?
4. Is surveillance done only for planned debris?

The Federal Aviation Administration (FAA) presented interesting air traffic data. Current practice is to determine aircraft hazards areas based on an aircraft the size of a 747. Air traffic data suggests that using an aircraft the size of 747 may be too conservative of an approach and indicates that a 737-sized aircraft may be more appropriate. This discussion will continue within the RC over the next six months to a year.

In the FTSC, status updates were provided on EFTS upgrades at White Sands Missile Range, Wallops Flight Facility, and Dryden Flight Research Center. Herley Industries provided a briefing on their new FTS receivers updating from the HFTR60-1 model to the HFTR60-2 model. Wallops Flight Facility also provided an update on their efforts in AFSS development. The committee then went over comments on proposed updates to the RCC 319 document.

For more background and information on the Range Commanders Council and the Range Safety Group, *click here*.

3. Common Standards Working Group (CSWG)

The Common Standards Working Group (CSWG) is an interagency organization that was formally chartered in 2004 to "establish common public safety requirements for space transportation at Federal and non-Federal sites." This includes the launch and reentry of expendable and reusable vehicles. NASA is a founding member of the CSWG, which was initially co-chaired by the FAA and USAF. In 2010, the CSWG revised its charter to incorporate NASA as a tri-chair and designated the Office of Safety and Mission Assurance (OSMA) Chief Engineer as the NASA member of the Senior Steering Group (SSG) that provides senior executive leadership and guidance to the CSWG. Each agency has a designated tri-chair representative identified and confirmed by the SSG membership; the tri-chairs are responsible for executing the direction of the SSG via the various CSWG subgroups. Mike Dook is the designated NASA tri-chair for the CSWG.

In 2011, one of the primary areas of focus was launch vehicle Probability of Failure (POF). The CSWG has worked to develop a set of guidelines for POF analysis for new expendable launch vehicles. CSWG members from the FAA, Air Force Space Command (AFSPC), 45th Space Wing, 30th Space Wing, and NASA (WFF, KSC, and HQ) have worked together diligently to develop this guideline for use in future launch vehicle analysis. This group will continue to work to provide a common set of guidelines that all members can utilize for future endeavors.

In 2011, the CSWG was asked by various range users to involve the range safety community in a review of Flight Termination System battery requirements to allow for current designs to meet the intent of the requirements. The FAA, NASA, and Air Force personnel collaborated to discuss the concerns raised by the range user community and resolved the issue by making minor changes to the battery requirements which will be implemented in the next version of AFSPCMAN 91-710 Volume IV and RCC 319.

B. Independent Assessments

NASA Range Safety supports NASA HQ audits and reviews on a regular basis, including Institutional/Facility/Operational (IFO) audits and Inter-Center Aircraft Operations Panel (IAOP) reviews. NASA Range Safety participated in IAOP reviews at JSC in April 2011, LaRC in September 2011, and Goddard Spaceflight Center/Wallops Flight Facility (GSFC/WFF) in October 2011. NASA Range Safety participated in an IFO audit at GSFC/WFF, also in October 2011.

The IAOP provides peer review and objective management evaluation of the procedures and practices being used at the operating centers to ensure safe and efficient accomplishment of assigned missions and goals. The review teams also identify deficiencies in, or deviations from, Agency-wide NASA policies, procedures, and guidelines. The primary focus of the Agency Range Safety Program during IAOP reviews is on the application of range safety requirements and techniques to NASA operations involving UAS. The intersecting aviation safety and range safety requirements that apply to NASA UAS operations dictate the need for close coordination between the NASA aviation and range safety offices. To facilitate a coordinated review process, NASA Range Safety personnel participate in IAOP reviews at NASA Centers that conduct and/or host UAS operations. At this time, those Centers include: ARC, DFRC, LaRC, and GSFC/WFF. KSC and SSC expressed interest in future UAS operations. Range safety findings during IAOP reviews and associated Center corrective actions are documented and tracked using IAOP systems and processes established by the NASA aviation office. The

Range Safety team participated in the IAOP reviews at JSC, LaRC, and WFF to understand each Center's Range Safety Office UAS support activities and to assess compliance with NPR 8715.5 requirements.

The IAOP review at JSC represented an opportunity to assess the Center's Morpheus project and potential range flight operations at JSC. Morpheus is a vertical test bed demonstrating new green propellant propulsion systems and autonomous landing and hazard detection technology. Morpheus is designed, developed, manufactured, and operated in-house by engineers at JSC (for more on Morpheus go to http://morpheuslander.jsc.nasa.gov/). Morpheus falls into the category of a guided suborbital reusable rocket. To date, Morpheus operations at JSC have been limited to tethered test firings, where the vehicle is suspended from a crane on cables that limit any vehicle motion. During the JSC IAOP review, the Range Safety team focused on plans for potential low altitude, untethered test flights at JSC. Such flights would be subject to NASA range flight safety requirements.

Range operations other than UAS operations are subject to IFO audits led by the NASA Safety Center (NSC). Such non-UAS range operations include space launch/entry and scientific balloon operations. NASA Range Safety participates in IFO audits of NASA centers that conduct and/or host non-UAS range operations. At this time, those centers include KSC and GSFC/WFF. Range Safety findings during IFO audits and associated center corrective actions are documented and tracked using IFO systems and processes established by the NSC. The Range Safety team participated in the IFO audit at GSFC/WFF to understand the Center's Range Safety Office support for orbital and suborbital space launch and scientific balloon activities and to assess compliance with NPR 8715.5 requirements.

C. Range Safety Training 2011 Updates

The NASA Range Safety Training Program was initiated in 2004. To date, NASA Range Safety has conducted over 48 training courses for NASA, Department of Defense (DoD), Federal Aviation Administration (FAA), and contractor personnel. The course breakout and number of students is shown in Figure 1.

Courses	# Classes	# Students
Range Safety Orientation	26	684
Range Flight Safety Analysis	7	127
Range Flight Safety Systems	11	151
Range Safety Operations	4	24

FIGURE 1: TOTAL NUMBER OF CLASSES AND STUDENTS TAUGHT

NASA Range Safety taught three NASA Safety Training Center (NSTC) sponsored classes in 2011. The dates are listed below in Figure 2.

Course	Date	Location
Range Safety Orientation	26-27 Apr	KSC
Range Flight Safety Systems	2-4 Aug	KSC
Range Safety Orientation	30-31 Aug	KSC

FIGURE 2: 2011 NSTC COURSE SCHEDULE

As in past years, NASA Safety Training Center (NSTC) funding has been severely reduced for 2012. Therefore, the two classes that were scheduled for FY12 have been cancelled. However, there are plans to teach the Flight Safety Systems course at Wallops Flight Facility (WFF) in early 2012. There are also plans to teach the first pilot course of the revamped Flight Safety Analysis course in spring of 2012 with possible follow-on classes in summer of 2012. The Range Safety Operations course will also be taught at WFF with new instructors in early 2012 with possible follow-on classes as well.

In addition to the NSTC courses being taught, the Commercial Crew Program (CCP) also requested that all four classes be instructed for their program and interested parties. As shown in Figure 3, two Range Safety Orientation classes were taught in October at KSC. A CCP Flight Safety Systems course was also taught in December. The current Flight Safety Analysis course will be taught twice as well at KSC in early 2012. There are also plans to teach two Range Safety Operations classes at WFF in early 2012.

Course	Date	Location
Range Safety Orientation	6-7 Oct 2011	KSC
Range Safety Orientation	13-14 Oct 2011	KSC
Range Flight Safety Systems	7-8 Dec 2011	KSC
Range Flight Safety Analysis	7-10 Feb 2012	KSC
Range Flight Safety Analysis	20-23 Mar 2012	KSC
Range Flight Safety Operations	Early 2012	WFF
Range Flight Safety Operations	Early 2012	WFF

FIGURE 3: COMMERCIAL CREW PROGRAM COURSE SCHEDULE

Another Agency Range Safety Training initiative is to provide hands-on training of the Joint Advanced Range Safety System (JARSS) Tool to multiple NASA centers that are or will be performing flight operations with a need to perform range safety risk analysis. This tool will provide that capability to the Range Safety Representatives at each respective center. This training will be provided to Ames Research Center (ARC), Stennis Space Center (SSC), and Langley Research Center (LaRC) in early 2012. Dryden Flight Research Center (DFRC) and Wallops Flight Facility (WFF) currently utilize this tool, and by providing this capability to other NASA centers, the NASA Range Safety Program ensures that each center has the necessary tools to protect NASA personnel, property, and the general public from possible hazards occurring from range/flight operations.

1. Range Safety Orientation (SMA-SAFE-NSTC-0074)

The Range Safety Orientation Course is designed to provide an understanding of the Range Safety mission, associated policies and requirements, and NASA roles and responsibilities. It introduces the students to the major ranges and their capabilities, defines and discusses the major elements of range safety (flight analysis, flight safety systems, and range operations), and briefly addresses associated range safety topics such as ground safety, frequency management, and unmanned aircraft systems (UASs). The course emphasizes the principles of safety risk management to ensure the public and NASA/range workforces are not subjected to risk of injury greater than that of normal day-to-day activities.

The Range Safety Orientation Course is designed to inform the audience of the services offered by the Range Safety organization, present timeframes that allow adequate interface with Range Safety during program/project startup and design in an effort to minimize potential delays and costs, and recommend ways of making the working relationship with Range Safety the most beneficial for the Range User. This course includes a visit to Range Safety facilities at Cape Canaveral Air Force Station (CCAFS)/KSC when the course is presented at the Eastern Range (ER). If you wish to discuss presenting the class at your location, please contact the NSTC staff.

Target Audience:

- Senior, program, and project managers
- Safety, Reliability, Quality, and Maintainability professionals with an interest in range safety activities

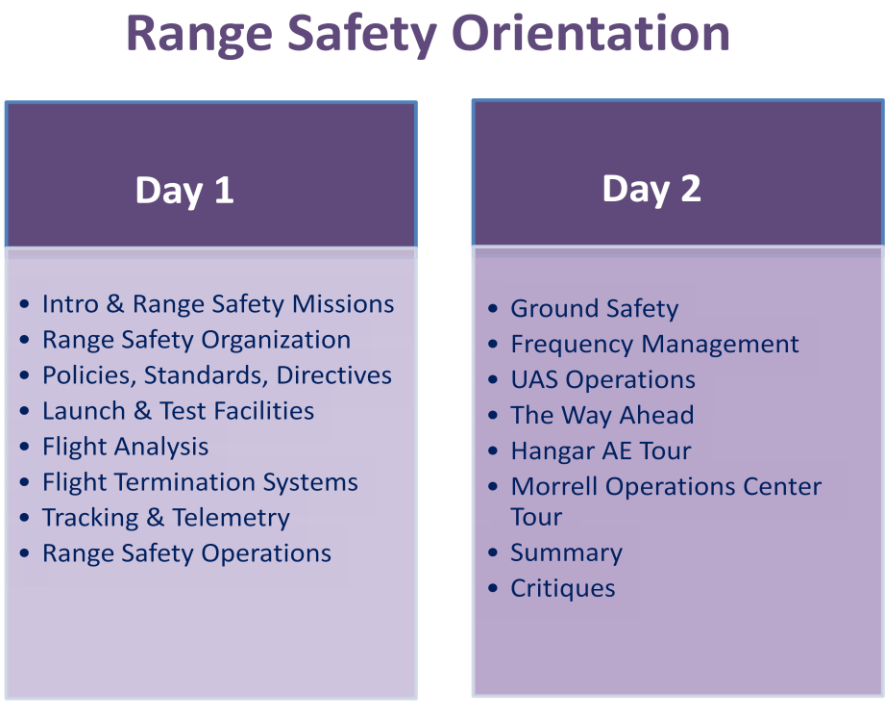

FIGURE 4: RANGE SAFETY ORIENTATION COURSE OUTLINE

2. Range Flight Safety Analysis (SMA-SAFE-NSTC-0086)

The Range Flight Safety Analysis course was not conducted in 2011 due to lack of funding. In the interim, however, the NASA Range Safety (NRS) office is continuing the development of a new NASA-centric course. The new course is designed to provide a broader understanding of Range Safety considerations, but it will focus more on NASA processes rather than on Air Force procedures at the Eastern Range. The current course will remain a standalone offering for DoD and FAA customers. It includes NASA, DoD, and FAA requirements for flight safety analysis (FSA); a discussion of range operations hazards, risk criteria, and risk management processes; and in-depth coverage of the vehicle containment and risk analysis methods performed for expendable launch vehicles (ELVs). An outline of the current FSA course structure is shown in Figure 5.

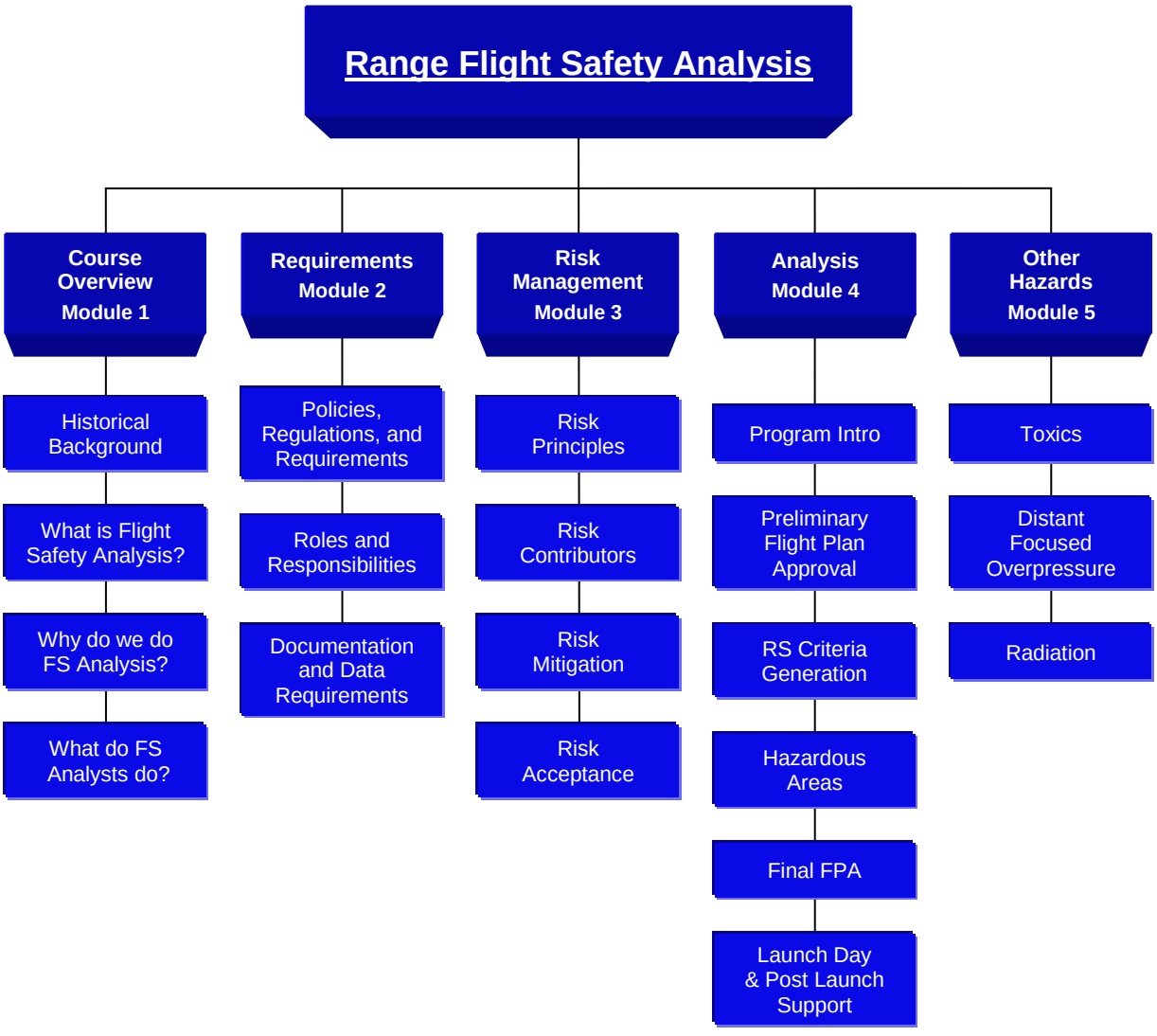

FIGURE 5: CURRENT FSA COURSE OUTLINE

The new FSA course will cover methods used for other vehicles such as reusable launch vehicles (RLVs), UASs, and research balloons. In addition, it will highlight unique range safety

processes used at several NASA ranges. There will still be coverage of debris hazards and related analyses, as well as an overview of toxic, blast, and radiation hazards and risks. Class exercises will be used to cover key aspects of FSA in a way that helps students absorb the information presented. Figure 6 outlines the new FSA course structure.

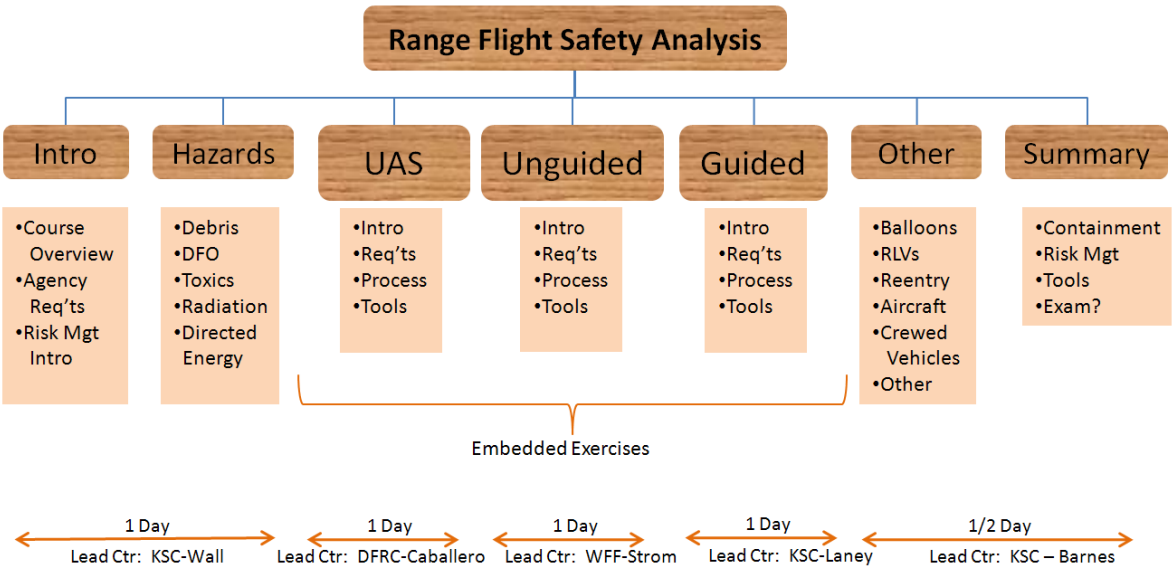

FIGURE 6: NEW FSA COURSE OUTLINE

NRS staff at KSC are developing a hazards module to form the backbone for the new course. This material will cover common aspects of FSA so that in later modules, more space can be devoted to methods and processes specific to particular ranges and vehicle types. Selected material has been extracted from the current FSA course and updated to support the new course, particularly for the Toxic Hazards and Distant Focused Overpressure (DFO) modules. Two rapid development sessions were held this summer: one at WFF to concentrate on an Unguided Vehicles module, and the other at DFRC to develop a UAS Vehicles module. Other modules to be developed by KSC include a Guided Vehicles module to cover ELVs and an Other Vehicles module to cover RLVs, re-entry vehicles, aircraft, etc.

Prerequisite: Completion of NSTC Course 074, "Range Safety Orientation," or equivalent experience.

Target Audience:

- NASA, FAA, and DoD Range Safety analysts
- Range Safety personnel in other disciplines
- Program/project managers and engineers who design potentially hazardous systems to operate on a range

3. Range Flight Safety Systems (SMA-SAFE-NSTC-0096)

The Flight Safety Systems (FSS) Course describes FSS responsibilities and Flight Termination System (FTS) design, test, performance, implementation, analysis, and documentation

requirements. The course also includes a review of Unmanned Aerial Vehicle (UAV) flight termination systems, balloon universal termination packages, and the Enhanced Flight Termination System (EFTS). The FSS class concludes with a description of the Autonomous Flight Safety System (AFSS) and a tour of the Naval Ordnance Test Unit (NOTU) facilities when the class is held at Kennedy Space Center.

Prerequisites:

1. Completion of NSTC 074, "Range Safety Orientation," or equivalent level of experience or training, is required
2. Completion of NSTC 002, "System Safety Fundamentals," or NSTC 008, "System Safety Workshop," is recommended

Target Audience:

- NASA, FAA, and DoD Range Safety Personnel working Flight Safety Systems issues
- Range safety personnel in other disciplines
- Program/project managers and engineers who design potentially hazardous systems to operate on a range
- Personnel who conduct hazardous operations on a range

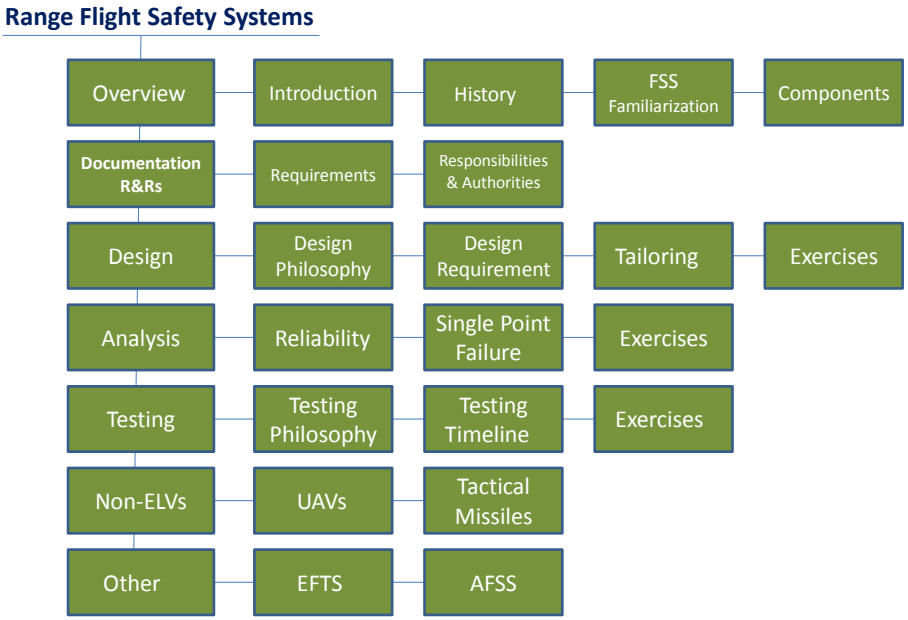

FIGURE 7: RANGE FLIGHT SAFETY SYSTEMS COURSE OUTLINE

4. Range Safety Operations Course (SMA-SAFE-NSTC-0097)

To ensure mission success and safe operations for the range, a formal process has evolved within the range community to provide range safety operations. This course addresses the roles and responsibilities of the Range Safety Officer (RSO) for range safety operations as well as real-time support, including pre-launch, launch, flight, re-entry, landing, and any associated mitigation. Mission rules, countdown activities, and display techniques are presented.

Additionally, tracking, telemetry, and vehicle characteristics are covered in detail. Finally, post operations, lessons learned, and the use and importance of contingency plans are presented. Students receive hands-on training and exercises to reinforce the instruction.

This course is only presented at WFF and is limited to six participants. To reduce cost and increase course availability, the goal is to have WFF personnel instruct this course beginning in 2012. NASA Range Safety will help organize the first courses to be taught and possibly provide instructors. The NASA Range Safety Office will still continue to review and control the course content to ensure its applicability across all centers.

Prerequisites:

1. Completion of NSTC course 074, "Range Safety Orientation," or equivalent experience and/or training, and a background in range safety
2. Completion of NSTC course 0086, "Range Flight Safety Analysis," or equivalent experience and/or training
3. Completion of NSTC course 0096, "Flight Safety Systems," or equivalent experience and/or training

Target audience: Persons identified as needing initial training for future/current job as RSO with NASA or RSO management.

FIGURE 8: RANGE SAFETY OPERATIONS COURSE OUTLINE

If you wish to attend any of the courses offered, please contact your center training manager, or refer to the NSTC web site course catalogue located at: https://satern.nasa.gov/elms/learner/catalog/